Liquefied Natural Gas Fuel System
Users’ Manual

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II. Preface

This manual is designed as a supporting document to mechanics and operators trained in the operation and maintenance of liquefied natural gas (LNG) fuel systems by Agility.

No attempt should be made to fill, install, or maintain systems until this manual and all referenced supporting documentation have been read and fully understood.

III. Warning Statements Used in this Manual

⚠️ DANGER

Personal injury or death will occur if procedures are not followed.

⚠️ WARNING

Personal injury or death may occur if procedures are not followed.

⚠️ CAUTION

Damage to equipment, fuel system or vehicle is possible if instructions are not followed.

⚠️ NOTICE

Best practices or hints to help an operation or procedure go smoothly.
IV. Obtaining Product Support, Service or Parts

Fuel system in- or out-of warranty product support can be obtained by calling the Agility Fuel Solutions Customer Care Hotline at 949-267-7745 or toll free: 855-500-2445.

Customer Care: support@agilityfs.com

Parts: parts@agilityfs.com

Visit our website for more information, including CNG and LNG fuel system videos. Go to www.agilityfuelsolutions.com

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1. Natural Gas Facts

**CAUTION**

This manual is intended as a supplement to training in operation of LNG fuel systems. Attempting to operate or maintain any LNG fuel system without proper training is dangerous.

- Never smoke or use an open flame near an LNG vehicle.
- Don't allow sparks, flames, or heated particles to come within six feet (2m) of the vehicle.
- Never attempt to depressurize or vent a system by loosening a fitting.
- Never adjust, remove or tighten a fitting or connector on a fuel system that is under pressure.

Natural gas is flammable; however, it only burns within a narrow range when mixed with air in a ratio of between 5 and 15 percent. CNG *will not* burn in the highly concentrated form found inside the cylinders.

LNG is odorless, tasteless and non-toxic. It is also cryogenically cold, so it *cannot* be odorized. LNG vehicles must not be stored indoors and methane detection systems must be present in the service facility.

Natural gas is lighter than air so it rises and diffuses into the atmosphere when released.

2. LNG Vehicle Identification

All LNG Vehicles must display this blue diamond symbol. It must be visible from the rear at all times, above the rear bumper.

*Figure 1 Blue Diamond LNG decal on a transit bus.*
3. LNG Fuel System Configurations

Agility fuel systems are optimized to meet specific end-user applications. The most common LNG fuel system configuration has two high volume LNG tanks mounted on each side of the vehicle chassis.

![Image](image_url)

*Figure 2 LNG vehicles feature super-insulated, stainless steel tanks mounted to the sides of the vehicle. LNG tanks may be mounted on other locations to suit requirements and fuel capacity. Note, the protection cover is removed in this view.*

4. LNG System Components and Fuel Flow

![Image](image_url)

*Figure 3 LNG tank showing valves and related components.*
Highly insulated stainless steel tanks store the LNG fuel. Several fuel flow control components are mounted on the end of the tank, as seen in Figure 3.

The red-handled liquid fuel shut-off valve on each tank allows that tank to be isolated for service, but is **open during operation**.

The gray-handled vent valve allows excess vapor to be returned to the station during fueling, and is **normally closed**.

LNG systems have an automatic shutoff valve. Only when the key switch is turned on will fuel flow to the engine for operation.

Multiple tanks operate in parallel. The operator does not have to fill them separately or select which tank is being used. Instead, the system has a single fuel fill and a single vent-to-station connection. See Figure 4.

**Figure 4** Dual tanks are connected in parallel and fueled from one side.

Other components of the system include interconnecting tubing and hoses, a heat exchanger (also called a vaporizer), and fuel control devices including the automatic fuel shutoff (solenoid) valve, overpressure regulator and pressure control regulator. See Figure 5.

**Figure 5** The heat exchanger assembly (covers removed).
The gauge on the heat exchanger assembly indicates pressure at the regulator output. It normally should read between 125 and 148 psi.

The electronic control unit (ECU) converts signals from the fuel level sender to the in-cab fuel gauge to indicate fuel level to the driver.

A low temperature warning light, located on the cab dashboard, reports an abnormally cold fuel system condition. If this light is illuminated, the vehicle should not be operated and must be repaired.

**CAUTION**

A low-temperature warning light (if equipped) is mounted on the vehicle dashboard. It will illuminate if the fuel supplied to the engine is abnormally cold. If this light is on, the vehicle should not be operated and must be repaired.

5. Vehicle Accidents and Incidents

**NOTICE**

Refer to Agility Fuel Solutions “First Responder Guide,” ENP-084, for CNG and LNG firefighter information.

5.1 If the vehicle is damaged, or a gas leak is detected:

1. Do not approach the vehicle if any sources of ignition are present, including but not limited to: fire, sparks, electrostatic charges, power lines, lights or electronic devices.
2. Do NOT smoke or allow anyone to smoke in the vicinity of the vehicle.
3. Do NOT set out road flares.
4. If it is safe to do so, shut off the ignition switch and isolate the fuel by closing both the red and grey-handled valves located at the end of all LNG tanks.
5. LNG is NOT odorized. A leak may cause ice or frost to form.
6. Make sure traffic and pedestrians stay clear.
7. Keep the vehicle doors open for air circulation.
8. If LNG spills on the pavement, do not spray it with water. Water can cause LNG to splatter violently, increasing fire danger. Allow the LNG to vaporize and dissipate into the atmosphere.
9. Leaks must be repaired by qualified natural gas fuel system service technicians.
6. Fueling

**WARNING**

When working with LNG, personal protective equipment (PPE) is required to help avoid injury. Skin contact with LNG, cold gas or tubing carrying it will cause cold burns or frostbite. Blindness can result if LNG gets in your eyes.

6.1 When Fueling

- Always wear safety glasses, a face shield, insulated gloves, long pants, a long sleeve shirt, and proper footwear.
- Do not smoke.

**NOTICE**

These are general guidelines. Always check with your fuel station for specific pump operating instructions and procedures.

6.2 Proper Fuel Selection

**CAUTION**

Putting blue (cold) LNG into a standard Agility fuel system will cause a low pressure condition and the engine will not run.

Agility’s standard LNG systems require a minimum tank pressure of 100 psi, which corresponds to a minimum fuel temperature of -200°F (-129°C).

LNG at this temperature is called saturated or green LNG, differentiating it from colder, or blue, LNG. The only difference between green and blue LNG is the temperature at which the fuel is dispensed into the vehicle.

6.3 Fueling Procedure

1. Always wear proper PPE.
2. Connect the ground cable from the pump to the vehicle tank.
3. If pressure inside the tank exceeds 150 psi, clean the vent connector with compressed air and connect the vent hose from the filling station to the tank vent connector.

4. Open the gray-handled vent valve on each tank and allow the system to vent down to about 140 psi. This allows the fuel dispenser to overcome the pressure in the tank and flow fuel into the tank.

5. Once 140 psi is achieved, close the vent valves and return the vent hose to the filling station. Never leave the vent hose connected with the vent valve open during the fueling process, or fuel may be returned to the station.

6. Use compressed air to clean the fill receptacle and nozzle.

7. Insert the nozzle into the receptacle, lock it in place and begin fueling.

8. The pump will shut off automatically when the fill is complete.

9. Disconnect and return the nozzle to the fuel pump.

10. Replace the receptacle cap and remove the ground cable.

Note: The single receptacle will fill all tanks.

6.4 LNG Fuel Temperature Versus Fuel Pressure

It is important to understand that pressure in the tank is directly related to the **temperature** of the fuel, not the **amount** of fuel in the tank. When the temperature in the tank increases, the pressure increases. When the temperature decreases, the pressure decreases.

Even though the tank is very well insulated, a small amount of heat is always flowing into the tank from the outside, so pressure will gradually rise at a rate of approximately 10 to 15 psi per day, equivalent to about 3°F to 5°F per day.

A series of regulators and valves manage the pressure in the tank so it never exceeds 230 psi and the pressure delivered to the engine never exceeds 150 psi.

If the tank pressure reaches 230 psi, the pressure relief valve will vent gas to the atmosphere. This is normal if the vehicle is parked and unused for a long period.

Each tank has its own mechanical gauge to indicate the pressure inside. Usually, there are two pressure gauges: One on the side of the tank and one on the valve end of the tank.

7. Daily System Inspection

Before operating your vehicle, we recommend that you perform this daily inspection to ensure it’s safe and ready for the road.

1. The engine manufacturer recommends that you drain the low-pressure filter daily **before** starting the vehicle. Follow the manufacturer’s instructions to see if you are getting oil or water in your fuel.
2. Then, before entering the cab, check the Methane Detection Center for a safe condition (green light).

3. In the cab, turn the ignition key to the “on” position and check the fuel level shown by the dashboard fuel gauge.

4. Check the tank pressure gauge, which should show between 100 and 230 psi.

5. Make sure the red cap on the pressure relief valve on each tank is in place.

6. Check that the red-handled fuel shut off valve is open and the grey-handled vent valve is closed on each tank.

7. As part of your normal walk-around, check the system for damage, the sound of leaks, ice or frost. But keep in mind that some frost is normal around the connections at the center or end of the tank.

If everything checks out okay then the vehicle is cleared for operation.

8. Pressure Relief Valves

On the back of the tank, the primary relief valve will vent gas to the atmosphere if pressure exceeds 230 psi.

If tank pressure is above 240 psi, the primary relief valve is not functioning correctly. The vehicle must be immediately removed from service and the primary relief valve replaced.

If the secondary relief valve red cap is missing, the primary relief valve may have failed, causing the secondary relief valve to open. The vehicle must be immediately removed from service, inspected and repaired.

9. Ice and Frost on LNG Fuel System Components

While fueling, it is normal for frost and ice to appear on the fuel nozzle, tanks, tubing and fuel lines. More frost and ice will form in humid or damp weather.

However, when ice buildup becomes excessive as shown in Figure 6, it should be removed to eliminate interference with the operation of the hand valves.

Remove ice build-up by gently flowing water from a hose. Never use tools to chip away ice.

A service technician should check the system for leaks.
Figure 6 Excessive ice like this may indicate a fuel leak.

10. Low Temperature Warning

⚠️ CAUTION

A low-temperature warning light is mounted on the vehicle dashboard. It will illuminate if the fuel supplied to the engine is abnormally cold. If this light is illuminated, the vehicle should not be operated and must be repaired.

11. Methane Detection

NOTICE

In some cases Agility supplies a methane detection system as part of the fuel system; otherwise it is supplied by the chassis original equipment manufacturer. In cases where the system is supplied by the chassis OEM, the system may be configured differently – check with your vehicle manufacturer for more information.
Because LNG is odorless and invisible, all LNG vehicles are equipped with a methane detection system that sounds an alarm and illuminates a warning light if methane gas is detected.

There are usually two detection zones on the vehicle where sensors are placed. Zone 1 is generally inside the cab. Zone 2 is inside the engine compartment.

If dangerous levels of methane are detected in the cab or the engine compartment, progressive warnings will be displayed on the driver’s dashboard. Lights indicate trace levels of methane. Significant levels trigger lights and a buzzer. These warning signals may be different in your vehicle. Refer to your vehicle operation manual for specific details.

12. Routine Maintenance
The LNG system is fairly simple. Other than surface cleaning of the system covers and fill receptacles, no maintenance of the fuel system components is needed.

13. Troubleshooting

13.1 Problem: The Engine Cranks But Won’t Start
1. Make sure the red-handled 1/4-turn shut-off valve and all cylinder valves are open.
2. See if the fuel system is providing proper fuel pressure to the engine by checking the high- and low-pressure gauges at the FMM. Normal ranges are: high pressure greater than 500 psi and low pressure 125 ± 10 psi.
3. Note: High pressure less than 500 psi may operate but the engine may not run at full power.
4. Check the condition of the chassis fuse for the FMM.

13.2 Problem: The Engine Will Not Crank
1. Make sure all of the receptacle caps and FMM doors are properly closed.
2. The vehicle starting battery must be good and fully charged. Low voltage while engine is cranking may cause the solenoid valve to remain closed, preventing fuel from flowing to the system.

13.3 Problem: Engine (Driver) Warning Light(s) On
If you see the amber Check Engine driver warning light, engine performance may be affected. Contact your fleet or service manager as soon as practical.
The red Stop Engine driver warning light means the engine may shut down automatically within 30 seconds. Immediately stop where safe, shut down the engine and contact your fleet or service manager.

14. Special Towing Precautions for LNG Vehicles

Fuel tanks should be empty when decking, piggy backing or towing to prevent liquid fuel from spewing out of the vent stack.

If an LNG vehicle with fuel aboard must be transported or towed, precautions must be followed to prevent liquid fuel from venting out.

1. In all cases, fuel gauges must read less than 1/8 full.
2. Drive or run the engine to reduce tank pressure to the pressure control regulator set point (120 psi) before mounting to the tow vehicle.
3. The driver must monitor pressure on all decked or towed truck tanks at the beginning and end of each trip.
4. The tanks must not exceed 200 psi at any time. Any tank at or above 200 psi must have the tank pressure reduced to below 180 psi by either running the engine or manually venting.

15. Agility Fuel Systems Product Support

If you are experiencing a problem with your vehicle or are uncertain about any process or procedure, contact the Agility Fuel Solutions Customer Care center hotline at 949-267-7745 or e-mail us at support@agilityfs.com.

When you e-mail or call, we will need your name, phone number, e-mail address, and the vehicle information: VIN, unit number, year, make, model, the name of the vehicle owner and its current location. We will assign a service advisor who will contact you and make arrangements to have your vehicle fixed or a part shipped.

For more detail, consult additional Agility resources such as Operation Manuals, Parts Manuals or the LNG Overview Video. These are available from our website, www.agilityfs.com.